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(54) IMPROVEMENTS IN OR RELATING TO HEAVY DUTY PNEUMATIC TYRES

(71) We, INDUSTRIE PIRELLI SpA, an Italian Company of Centro Pirelli, Piazza Duca d'Aosta No, 3, Milan 20100, Italy, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The present invention relates to heavy duty pneumatic tyres for vehicle wheels. Particularly it relates to heavy duty penumatic tyres provided with a radial carcass (i.e. a carcass whose cords lie in radial or substantially radial planes) of metallic cords.

It is known that the radial carcass tyres are very flexible in the sidewalls zone and consequently the carcass becomes greatly deformed in this zone when loaded.

On the other hand, in order to give good driving and behaviour characteristics to the tyre, the bead must be stiff, with a stiffness greater than the load.

It is conventional in a mono-ply radial tyre having a metallic carcass for the carcass ply to be turned up around the bead core, from the inside toward the outside with respect to the tyre into the zone facing the flange of the mounting rim.

A rubber filler of elongated, substantially triangular cross-sectional shape, is assembled adjacent and radially outwards of the head-core, said filler being to stiffen the bead. Axially outwards of the carcass ply the bead is provided with a reinforcing chafer of rubberised metallic cord fabric. The chafer extends radially outwards of the end of the turnup of the carcass ply and the rim flange, and radially inwards towards the bead core, sometimes overlapping the radially inner surface of said bead core.

In an axially outer position with respect to this reinforcing chafer, a protective strip of rubber which is resistant to abrasion, in order to resist the rubbing action against the rim flange, can be provided. Other different strips and fillers for the completion of the bead may be used in special circumstances.

It is clear that in every carcass there is a change from a high flexibility zone, as in the sidewall, to a high bending stiffness zone, as in the bead. This is in the form of a discontinuity which complicates the structure of this tyre zone.

The elimination of these discontinuities constitutes a large technical problem. In fact, the repeated cyclic deformations of the bead in the connection zone with the sidewall, where the stiffness rapidly reduces, may after a certain period of time, cause detachments among the different component elements resulting in the destruction of the bead in a short time.

It has been noted that said detachments take rise chiefly at the radially outermost end of the turn-up of the carcass ply or at the radially outermost end of the reinforcing chafer, among the metallic cords and the surrounding rubber. It is believed that these detachments are due to the contrast between the great stiffness of the metallic cords and the lower one of the rubber, in the presence of bending and compression stresses to which the tyre bead is subjected in service.

This explains also why all the attempts to raise the height of the turn-up of the carcass plies in order to increase the bead stiffness have not achieved the expected results in the past. The ends of these cords are located in a zone where the deformations and consequently the stresses are greater than at the zone at the height of the rim flange and by introducing a discontinuity, have already caused in a very short time the beginning of the detachments, thereby annulling in this way the advantages derived from the stiffening of the bead.

The most recent tests in this field, characterized by results greatly disagreeing with one another for relatively similar technical solutions, have now shown the existence in the conventional bead of a critical limited zone, which is difficult to calculate or to locate but situated just a little above the rim flange near to the zone of maximum width of the bead. If the ends of the aforesaid cords lie in this zone there are no detachments and the beads provided with a high turn-up give good results, which are better than those produced by the conventional beads. If the ends are outside said limited zone, the performance falls again unavoidably resulting in the disadvantageous detachments, described above.

However, the use of the bead with high carcass turn-up only gives good results with semi-finished products and an assembling technique of very high precision, with all the consequent costs and drawbacks.

On the other hand, in order to assure the constancy of the dimensions of the finished tyre, during its use, it is necessary to utilize in the carcass ply, metallic cords which are substantially inextensible and therefore of the "regular lay" type (i.e. those in which the twist given to the filaments of a strand is of an opposite sense with respect to that allotted to the strands to gather them in cords) which have an inherently high stiffness. Moreover, the necessity to obtain, in said fabrics, predetermined values of tensile strength fixes the diameter of the filaments of the cords and this diameter cannot be further reduced when the maximum admissible density is reached in the fabric.

In the field of heavy duty tyres, which are subject to involved high loads, despite using the maximum admissible density, the cords of the carcass ply are of such a dimension that their bending stiffness is considerably higher than that of the surrounding compound. This causes consequent discontinuity in the bending behaviour of the tyre and the aforesaid drawbacks.

However, the reinforcing chafer can extend radially outwards of the outer end of the turn-up of the carcass ply since the cords of this reinforcement are not subjected to tensile stresses due to the expansion of the carcass, so that filaments having a smaller diameter can be used and can be arranged not radially, but inclined of a certain angle with respect to the meridian planes. In this way the bending stiffness of this fabric is controlled through the choice of the value of said angle.

Of course, the maximum stiffness obtained till now with these beads is less than that desired for a very good behaviour of the tyre in service.

The present invention aims therefore at providing a radial tyre having a metallic carcass showing great stiffness beads in which the disadvantages referred to above are obviated or instigated.

Accordingly the present invention provides a heavy duty pneumatic tyre for vehicle wheels adapted, for being mounted on a corresponding wheel rim provided with two laterally spaced-apart rim flanges, said tyre comprising a mono-ply radial carcass of rubberised metallic cord fabric, the cords of which are substantially inextensible, two beads, each bead comprising a bead core of metallic wires, said carcass ply having each of its ends turned up around a respective bead core, a rubber filler of substantially traingular cross-section radially outwards of adjacent each bead core, and a reinforcing chafer disposed in the axially outer zone of the bead, said chafer being constituted by a strip of rubberised metallic cord fabric which extends to a position outwards of the turned-up end of the carcass ply, characterised in that said bead core is enclosed in a rubberised metallic cord fabric flipper, the cords of said flipper being of the "lang lay" type, the radially outermost edge of the axially outer part of the said flipper lying radially outwards of the turned-up end of the carcass ply and of the radially outer edge of said reinforcing chafer.

The best results are obtained by using for said flipper metallic cords oriented at an angle in the range between 60° and 90° with respect to the circumferential direction of the bead, particularly when they are arranged radially (at 90°) i.e. parallel to the adjacent cords of the carcass fabric.

As a further reference, the radially outermost edge of the axially outer part of said flipper is preferably arranged between two values, the lower of which is at least equal to the radius of the flange of said mounting rim, with its relationship to the upper end of the reinforcing chafer and of the turn-up of the carcass ply remaining fixed, whilst the higher is not greater than the radius of 50% of the section height of the tyre.

In each of the beads of a tyre according to the invetnion, the radially outermost edge of the turn-up of the carcass ply is preferably not higher than the height of the flange of the mounting rim.

The invention may be used in combination with other advantageous characteristics of the usual versions of the bead of heavy duty tyres, as for instance the reinforcing chafer which extends along the radially inner surface of the bead core, or the filler of the bead core, which, instead of being constituted by a single type of compound, is constituted by the assembling of two sections of different hardness compound, the section of higher hardness compound being directed towards the inside against the carcass ply and that of lower hardness being directed towards the outside against the outer edge of said flipper.

Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings in which:—

Figure 1 shows schematically the bead of a radial heavy duty tyre, according to the invention,

Figure 1a shows schematically a tyre section on which the section height H and the section width C, used for the definition of some critical values, are determined;

Figure 2 shows schematically a preferred embodiment of the bead of a tyre according to the invention.

With reference to Figure 1, which shows the bead of a metallic mono-ply radial heavy duty tyre, the bead of such tyre consists of a bead core 1, of metallic wires, on which, in a radially

outer position, a filler 2 is assembled. The filler 2 is made of a compound having a high degree of hardness and is of substantially triangular shape and tapered towards the radially outermost end. The carcass ply 3 turns up round the bead core. The turn-up stops above the bead core, in proximity of the flange B of the mounting rim 4.

On this bead, in an axially outer position, the reinforcing chafer 5 is assembled, the radially outermost end of said chafer 5 is assembled, the radially outermost end of said chafer rises radially above the rim flange and the turn-up end of the carcass ply.

The bead core 1 and at least part of the filler 2 are enclosed by a flipper of rubberised metallic cord fabric, whose reinforcing cords are of lang lay metallic cords.

Lang lay metallic cords comprise a plurality of strands, each of which comprise a pluraility of filaments. The strands in the cord are twisted in the same sense as the filaments are twisted in each strand.

Cords wound in this way show a stretch greater than that of the regular lay cords, due to the reduced winding pitches, and are known in the tyre art with the abbreviation HE (High Elongation), that is stretch equal to about 8%.

In particular, in the prototypes made by the Applicant, a metallic fabric has been used with a density of 4.5 (4.5 cords per cm) obtained with cords 3 x 7 x 0.20 H.E. winding pitch of the cord equal to 10.17 (i.e. three strands twisted with a pitch 6.3, each strand constituted by 7 filaments, having a diameter equal to 0.20 mm, twisted together with a pitch 3.87).

The upper edge of the axially outer part of the flipper 6 is at a very high radial height, and is higher than the upper edges of the reinforcing chafer and of the turn-up of the carcass ply. The upper end of flipper 6 may lie between the height of the flange and the 50% of the section height, particularly substantially equal to about 23% of the tyre section height.

Preferably the cords of flipper 6 are oriented radially, that is parallel to the cords of the carcass ply, although good results are obtained if they lie in the range between 60° and 90° with respect ot the circumferential direction of the bead.

This applicant has surprisingly found that by utilizing this type of reinforcing flipper, not only is it possible to obtain a stiffer bead than the usual one, owing to the flipper height but also a much more resistant bead, in which detachments occur later than in the conventional beads having a high ply turn-up. During tests made on said prototypes, an increase of the tyre life between 30% and 50% was noted.

It is believed that the benefits of the invention arise from the unexpected presence in the inner zone of the deformed bead, in service, of tensile stresses perhaps also of an entity higher than those of bending.

It is clear that in such a way the metallic cords of high elongation type which have an elongation greater than those of regular lay type follow the deformations of the rubber, thereby preventing the detachments.

Referring now to Figure 2, the bead besides having the flipper 6 as shown in Figure 1, has also a particular filler of the bead core constituted by the assembling of two strips 2A and 2B of different hardness compounds. The strip 2A, made of the compound which has the higher hardness, is arranged in an axially inner position against the carcass ply, whilst the softer strip 2B is arranged axially outside against the axially outer part of the flipper 6.

In this way, a third strip 2C is advantageously provided, of the same compound as the strip 2B, in order to cover the radially outer edges of the flipper 6 and of the reinforcing chafer 5.

Moreover, the bead of Figure 2 shows the chafer 5 which extends along the radially inner surface of the bead core, and turn-ups towards the axially inner part of the flipper 6, partially overlapping it.

Of course the various constructional features shown in Figure 2 can be adopted either together or separately from one another.

Besides the already mentioned improvement of the stiffness and life of the bead, the invention produces also another not unimportant economical advantage. Due to the presence of the flipper the siffness of the bead no longer depends substantially upon the carcass cords, so there is greater freedom of choice for the fabric of the carcass.

It is found that the height of the turn-up of the carcass ply can be reduced up to the minimum admissible value with a firm locking of the bead core during the building up operations, particularly during the shaping. Practically the turn-up is stopped at the bead core height, i.e. under the rim flange and therefore in a zone without deformations.

Since there is no longer the risk that these cords can produce some detachments, their stiffness and consequently the section of the filaments constituting the cord, can be conveniently increased enabling the use of cords of easier construction (greater section and therefore smaller number of filaments constituting the strands of the cord) and consequently of lower specific cost.

WHAT WE CLAIM IS:—

1. A heavy duty pneumatic tyre for vehicle wheels, adapted for being mounted on a corresponding wheel rim provided with two laterally spaced apart rim flanges, said tyre comprising a mono-ply radial carcass of rubberised metallic cord fabric, the cords of which are substantially inextensible, two beads, each bead comprising a bead core of metallic wires, said carcass ply having each of its ends turned-up around a respective bead core, a rubber filler of substantially triangular cross-section radially outwards of and adjacent the bead core, and a

reinforcing chafer disposed in the axially outer zone of the bead, said chafer being constituted by a strip of rubberised metallic cord fabric which extends to a position outwards of the turned-up end of the carcass ply, characterised in that said bead core is enclosed in a rubbersised metallic cord fabric flipper, the cords of said flipper being of the "lang lay" type, the radially outermost edge of the axially outer part of the flipper lying radially outwards of the turned-up end of the carcass ply and the radially outer edge of said reinforcing chafer.

2. A pneumatic tyre as claimed in claim 1, wherein the cords of said flipper are oriented at an angle in the range 60° to 90° with respect to the circumferential direction of the bead.

3. A pneumatic tyre as claimed in either of the preceding claims, wherein the cords of said flipper are parallel to the adjacent cords of the carcass fabric.

4. A pneumatic tyre as claimed in any one of the preceding claims, wherein the radially outermost edge of the axially outer part of said flipper lies between two values, the lower of which is at least equal to the radius of the flange of said mounting rim and the greater of which is not higher than the radius of 50% of the section height of the tyre.

5. A pneumatic tyre as claimed in claim 4 wherein the radius of the radially outermost edge of the axially outer part of said flipper is substantially equal to the radius of 23% of the section height of the tyre.

6. A pneumatic tyre as claimed in any one of the preceding claims, wherein the radially outermost edge of the turn-up of the carcass ply is not higher than the height of the flange of said mounting rim.

7. A pneumatic tyre as claimed in any one of the preceding claims wherein said reinforcing chafer extends along the radially inner surface of said bead core.

8. A pneumatic tyre as claimed in any one of the preceding claims wherein said filler is constituted by a single type of compound.

9. A pneumatic tyre as claimed in any of claims 1—7, characterised wherein said filler is constituted by the assembling of two sections of different hardness compound, the section of higher hardness compund being directed towards the inside against the carcass ply and that of lower hardness compound being directed towards the outside against the outer part of said flipper.

10. A pneumatic tyre as claimed in Claim 9, wherein in an axially outer position with respect to said reinforcing chafer there is located a rubber strip of a hardness substantially equal to that of said section directed towards the outside against the outer part of said flipper, said strip being placed to cover the radially outer ends of said flipper and of said reinforcing chafer.

11. A pneumatic tyre constructed and arranged substantially as herein described with reference to Figure 1 of the accompanying drawings.

12. A pneumatic tyre constructed and arranged substantially as herein described with reference to Figure 2 of the accompanying drawings.

R E S WALLER
Agent for the Applicants

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1589324 COMPLETE SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

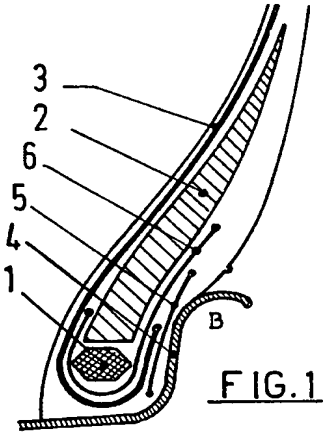

FIG.1

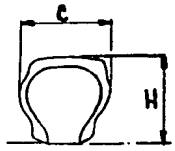

FIG.1a

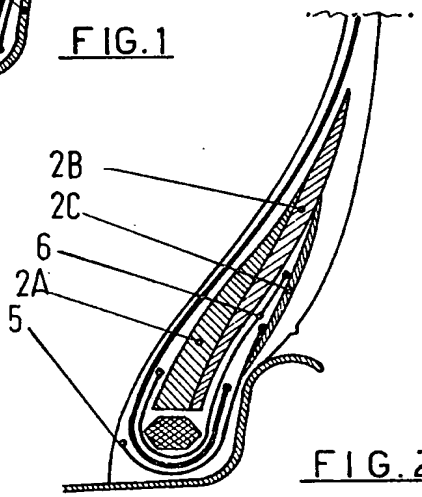

FIG.2